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(54) A MECHANISM FOR AUTOMATICALLY MEASURING AND DISPENSING UNIT QUANTITIES OF DRY POWDER

(71) We, PERRY INDUSTRIES, INC., a Corporation organised and existing under the laws of the State of Delaware, United States of America of, 121 New South Road, Hicksville, New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a mechanism for automatically measuring and dispensing unit quantities of dry powder. More particularly, this invention relates to an improvement to a mechanism believed to have been first described and claimed in United States Patent No. 2,540,059.

Means have long been provided for measuring unit quantities of dry powders volumetrically by applying a reduced pressure to the back side of what has been described as a foraminous membrane placed at a predetermined distance from the open end of a cavity, transferring the reduced pressure environment to the front side of such membrane and in so doing causing the cavity to become filled with dry powder when said open end is introduced thereinto. Maintenance of the reduced pressure (vacuum) holds the dry powder in the cavity. Termination of the reduced pressure and the immediate substitution therefor of an elevated pressure discharges the unit quantity of dry powder. By synchronizing the placement of a container such as a cartridge casing, ampoule, hard capsule body, or the like, in a predetermined location with the application of elevated pressure to the mechanism for measuring and dispensing unit quantities of dry powder when the latter mechanism is moved to such predetermined location accomplishes the dispensing of the unit quantity of dry powder into the container therefor.

United States Patent No. 2,540,059 teaches that 325 mesh stainless steel screen is eminently satisfactory for use as a foraminous material. Other materials suggested are sintered glass, sintered metals, felts, porcelains, and grained woods such as balsa wood. It is further taught that the foraminous material should not deflect during operations.

Stainless steel screen having a 325 mesh size has apertures of about 44 microns, far too large to prevent the passing of finely divided powders. Consequently such screen could only be utilised for such granular materials as gun powder. As a result, felt became the material of choice for use as the foraminous membrane in the measuring of unit quantities of very fine powders. However, felt suffers from the handicap of being a matted fabric that depends upon the development of a substantial thickness of fibers, one piled on top of another, to obtain the limited porosity to stop the passage of fine powder. This characteristic of construction provides ample opportunity for fine powder particles to become embedded in the felt pad and to resist dislodgement in the cycle wherein the pressure is first reduced and then elevated. Consequently, felt membranes sometimes become clogged quickly and must be replaced frequently, the finer the powder to which they are exposed the shorter the useful life of the membrane.

Other materials have been utilized with similar problems. For example various metal, ceramic and plastic materials have been cast or molded with pores of a controlled size. However, like felt, these materials depend on the build-up of a layer of some depth to provide the desired porosity, and consequently are generally rigid and somewhat inflexible.

The development of fabrics having minute apertures produced from synthetic monofilament fibers has provided much improved foraminous membranes which allow for the transfer of air at reduced and elevated pressure from one side to the other and which because of the reduced thickness of the fabric and the resiliency of the fibers

resist the build-up of embedded powder particles over repeated cycles of exposure to reduced and elevated pressure.

While the development of fabrics woven from synthetic monofilament fibers provided a significant improvement in the foraminous material utilized for the transfer of both reduced and elevated pressure to the cavity in which the unit quantity of dry powder is measured, new problems were encountered in the mounting, or attachment, of the fabric in the mechanism. The woven monofilament fiber does not have the "body" of any of the prior art foraminous material. Consequently, the fabric must be mounted under tension and such tension must be controlled so as to provide for just the right amount of flexion of the fabric under repeated cycles of reduced and elevated pressure. Moreover, the foraminous membrane must be movable within the confines of the walls which define the side of the cavity in which the unit quantity of dry powder is measured. Furthermore, only a small area of the end of the cavity defined by the foraminous membrane can be taken up by the support for the porous fabric as the area of the latter must be as large as possible in relation to the cross-sectional area of the cavity in order to spread the transfer of the reduced and elevated pressures over as wide an area as possible to avoid "dead" spots when dry powder can accumulate. And, in addition, the foraminous material, which serves as a filter to allow for the passage of fluid in both directions as first reduced and then elevated pressure is applied and coincidently restrict the passage of dry powder particles, does eventually become fatigued or clogged with embedded particles of dry powder and must be replaced.

Accordingly, this invention provides a quick change membrane assembly which incorporates a foraminous membrane, composed of a fabric woven of synthetic monofilament fibers, as a part of a filter element which can be replaced with a minimum of effort and time.

Another object of this invention is to provide a foraminous membrane as a part of a filter element which is mounted under an appropriate tension to control the flexion of the membranes fabric under repeated cycles of reduced and elevated pressure to minimize the embedment of dry powder particles in the membrane and thus increase the number of repeated cycles which will accrue before fatigue and clogging render the membrane unusable.

The present invention provides a mechanism for automatically measuring and dispensing unit quantities of dry powder comprising, means providing a metering cavity for the powder having a foraminous membrane at one side of the cavity, the opposite side of the cavity being open, means for supplying reduced and elevated pressure to the side of the membrane opposite the cavity, and said membrane comprising a piece of flexible fabric woven of synthetic fiber, such as nylon.

It has now been discovered that an attachment element having a key and a keyway as integral parts thereof; affixed to a means for communicating a supply of reduced and elevated pressure thereto in engagement with a corresponding integral key and keyway in a complementary filter element, movably disposed within the confines of a hollow cylinder constitutes a quick change membrane assembly wherein the filter element can be replaced almost instantaneously. A suitable tension for a foraminous membrane of a woven fabric comprised of synthetic monofilament fibers is provided by heat welding such fabric to a thermoplastic filter element body so that the deflection of a 0.250 inch cross section of such fabric is about 180 microns under a reduced pressure of about 18.0 inches of water (vacuum) and about 180 microns under an elevated pressure of about 9 psig.

Brief Description of the Drawings

Figure 1 is a vertical cross-sectional side view of the mechanism in which the quick change membrane assembly constituting the improvement in accordance with this invention is associated.

Figure 2 is a front plan view of the filter element portion of the quick change membrane assembly.

Figure 3 is a section of Figure 1 showing the quick change membrane assembly constituting the improvement in accordance with this invention.

Figure 4 is a perspective view of the attachment element of the quick change membrane assembly.

Figure 5 is a perspective view of the filter element of quick change membrane assembly.

The quick change membrane assembly which constitutes the improvement of this invention operates as described and illustrated hereinafter.

Referring to Figure 1, a filter element 1 is engaged with an attachment element 6 disposed within a hollow cylinder 12. The attachment element 6 is affixed, preferably by soldering 13 to a means 9 for applying reduced pressure or supplying pressurized fluid to the quick change membrane assembly, more prominently illustrated in Figure 3.

The reduced pressure and pressurized fluid supplying means 9 is attached to threaded nipple 16. Nipple 16 is movable within the confines of threaded coupling 15. The hollow cylinder 12 is screw thread mounted in the end of coupling 15 opposite

the end in which nipple 16 is movably disposed. A circumferentially milled channel 10 in attachment element 6 holds an O ring 11 which forms a seal between cylinder 12 and attachment element 6. The reduced pressure and pressurized fluid supplying means 9 is hollow and rigid and communicates between the movable nipple 16 and the movable attachment element 6.

As nipple 16 is moved back and forth in coupling 15, the cooperating elements 9, 6 and 1 are moved in the same direction. The machined threads 17 in coupling 15 extend along the longitudinal axis of the coupling a sufficient distance to allow the nipple 16 to be moved therein to a point where the engagement means of attachment element 6 extend beyond the open end of cylinder 12.

When the entire train of elements 16, 9, 6 and 1 is moved to the extended position described above, the filter element 1 can be instantly replaced. With the new filter element 1 in place, the entire train of elements 16, 9, 6 and 1 is retracted by turning nipple 16 in the reverse direction in coupling 15. The nipple 16 is retracted until all of filter element 1 has been withdrawn into cylinder 12.

The inside diameter of cylinder 12 is fixed, so the volume of powder which can be accommodated in space 21 at the open end of cylinder 12 is determined by the distance from the square edge of the open end of cylinder 12 to the face of filter element 1. Consequently nipple 16 is retracted in coupling 15 until the distance defined immediately above establishes a volume for space 21 that will accommodate the unit quantity of dry powder desired. A lock-nut (not shown) fixes the position of nipple 16 in coupling 15 when space 21 is appropriately defined.

The mechanism for automatically measuring and delivering unit quantities of dry powder is operated as follows: (a) The open end of cylinder 12 is introduced into a bed of dry powder, (b) a reduced pressure (vacuum) is applied to the open end of nipple 16 and communicated by measure means 9 to the attachment element 6 and subsequently to filter element 1, (c) a unit quantity of dry powder is drawn into space 21, (d) cylinder 12 is withdrawn from the dry powder bed and positioned over a container, such as a two-piece hard capsule body, ampoule, or the like, and (e) the unit quantity of dry powder is dispensed into the container by terminating the reduced pressure applied to nipple 16 and substituting therefor the application of a pressurized fluid which is communicated to filter element 1 forcing the unit quantity held in space 21 therefrom.

The quick change membrane assembly which constitutes the improvement of this invention is shown more distinctly in Figure 3, and attachment element 6 and filter element 1 are shown in perspective in Figures 4 and 5.

The filter element 1 is comprised of a plastic body which may be constructed of such thermoplastic materials as polyethylene, polypropylene, polyvinyl chloride, polystyrene, delrin, and the like, preferably polypropylene, and is essentially in the form of a hollow cylinder. There is welded to one end of the body a piece of tightly woven fabric composed of synthetic monofilament fibers such as polyester, rayon, acetate, nylon and the like, preferably nylon.

The attaching of the fabric to the body is best accomplished by selecting a fabric constituted of fibers which have a softening point higher than the softening point of the plastic body of the filter element. The fabric can then be welded to the body by applying localized heat to a portion of such body in the presence of the fabric sought to be welded thereto and maintaining such heat until the localized area is softened sufficiently to permit the embedding of the fabric in the softened plastic and then withdrawing the heat and allowing the softened plastic to cool, effectively welding the fabric to the body.

As indicated hereinbefore nylon is the preferred fiber. The preferred fabric is a monofilament nylon fiber tightly woven into a cloth in which the apertures between the fiber strands are about one micron. This permits the application of reduced pressure on one side of the fabric to be effectively transferred to the other side and to cause the dry powder to flow into space 21 from the differential in pressure between that present at the dry powder interface with the atmosphere and that in space 21, defined by the front face of the filter element 1 and the interior walls of cylinder 12. Furthermore the smallness of the apertures in the fabric effectively prevents the movement of particles of the dry powder through the fabric as only a minimum of particles of the dry powder have a diameter of less than one micron.

When the reduced pressure is terminated and pressurized fluid is supplied to the filter element, the pressurized fluid can flow through the small apertures and force the unit quantity of dry powder out of space 21 as defined above and dispense such dry powder into a prepositioned container.

It was found that fabrics woven of monofilaments of synthetic fibers, such as those enumerated hereinbefore have the characteristic of flexing inwardly when reduced pressure is applied to the filter element 1 and outwardly when pressurized fluid is supplied to such filter element. For example, when monofilament nylon cloth having an

unsupported diameter of 0.250 inch and one micron apertures were employed as the fabric welded to one end of filter element 1, the application of a reduced pressure measured as 18.0 inches of water (vacuum) produced a deflection of about 180 microns, and the application of 9 psig of compressed air produced a deflection of about 180 microns. The flexion of the monofilament nylon fabric under both reduced and elevated pressures provides the beneficial action of mechanically loosening particles of dry powder that become attached to the fibers or embedded in the apertures of the fabric. This action serves to keep the dry powder from building up on the filter element and impairing the efficiency of the operation. It is essential that the reduced pressure applied to the filter element must be transmitted at a constant level to the front face thereof in order to maintain the pick-up of a uniform unit quantity of dry powder in space 21 under repeated cycles of pick-up and delivery. The dispensing of the unit quantity must be fast and complete, and to ensure such need the supply of pressurized fluid to the front face of the filter element must be instantaneous, uniform across the area and constant in velocity. A build-up of dry powder on the fabric defeats these requirements. The flexion of the fabric as the alternate cycles of reduced and elevated pressures are applied aids in keeping the face of the filter element free of dry powder and greatly extends the number of cycles that a filter element can be effectively employed over the prior art materials and designs.

However, there comes a time after repeated cycles that, because of fatigue or a build-up of dry powder that can not be dislodged, the filter element must be replaced. When this occurs the quick change membrane assembly provides a means for an almost instantaneous removal of the old filter element and replacement by a new filter element. Figure 3 shows the quick change membrane assembly in a longitudinal vertical cross-sectional view. In Figure 3 the filter element 1 and the attachment element 6, are in place in cylinder 12, with the attachment element 6 securely affixed to the reduced and elevated pressure supplying means 9 with a silver solder bead 13, and in communication therewith. The means by which such membrane assembly is moved to a position where the quick change of filter element 1 can take place is discussed hereinabove.

Figure 4 shows a perspective view of attachment element 6 affixed to the supplying means 9 by the bead of solder 13. A longitudinal section of the end of attachment means 6 opposite the end affixed to the pressure supply means 9 has been removed to a depth of from about one-fourth to about three-fourths of the diameter and for a distance of from about one-fifth to about three-fifths of the length of the attachment element 6. The unremoved portion of the attachment element 6 is shown at 8 in Figure 4, and an additional portion is removed from the unremoved portion 8 to form a notch 7. About one-fourth to about three-fourths of the diameter of attachment element 6 remains intact in notch 7. Notch 7 constitutes a keyway in which key 4, shown in Figure 5, can fit. Each of notch 7 and unremoved portion 8 are approximately of equal length. Preferably, about three-fifths of the diameter of attachment element 6 remains in the unremoved portion 8 and two-fifths remain in notch 7. The attachment element 6 has an outside diameter of from about 0.005 to about 0.010 inches less than the inside diameter of cylinder 12.

A channel 10 is milled circumferentially around attachment element 6, and a neoprene, or the like, O ring 11 is disposed in the channel. The O ring is of a thickness such that the sides extend from about 0.008 to about 0.010 inch above the sides of attachment element 6, and serves as a seal between cylinder 12, and the attachment element.

Cooperation with attachment element 6 is filter element 1, shown perspectively in Figure 5. A section of filter element 1 is removed at the end opposite the end whereon there is an integral annular flange 3. As the improvement of this invention constitutes a quick change membrane assembly the section removed is equal in length to the length of the section removed from attachment element 6. However, the depth of the section removed in equal to the amount of the diameter of attachment element 6 remaining in notch 7. A notch 5 is made in the unremoved portion of filter element 1 to a depth equal to the amount remaining on the unremoved portion 8 of attachment element 6. Notch 5 constitutes a keyway in which key 8 can fit. Both unremoved portion 4 and notch 5 of filter element 1 are substantially of equal lengths and correspond with unremoved portion 8 and notch 7 of attachment element 6.

In order to assure any easy yet close fit, notches 5 and 7 are from about 50.5 to about 51.5 percent of the total length of the sections removed from both the attachment element 6 and the filter element 1.

The integral annular flange 3 molded in filter element 1 provides an outside diameter for filter element 1 at this point of from about 0.002 to about 0.003 inches less than the inside diameter of cylinder 12. The main portion of the body of filter element 1 has an outside diameter of from about 0.005 to about 0.010 inches less than the inside diameter of cylinder 12.

Figure 2 shows a front plan view of filter element 1 with the membrane fabric 2 welded thereto.

The outside diameter of attachment element 6 and filter element 1 is substantially the same. When the keys and keyways provided in the elements 6 and 1 are matched they cooperate to provide a positive attachment which is maintained by disposing both elements within the confines of cylinder 12. Only a minimum side-ways movement is possible and such is not sufficient to disengage the two cooperating elements. Yet the moment filter element 1 is moved to a position where it is totally outside cylinder 12 an instantaneous disengagement is possible and a quick replacement of a defective filter element 1 is readily accomplished.

WHAT WE CLAIM IS:—

1. A mechanism for automatically measuring and dispensing unit quantities of dry powder comprising, means providing a metering cavity for the powder having a foraminous membrane at one side of the cavity, the opposite side of the cavity being open, means for supplying reduced and elevated pressure to the side of the membrane opposite the cavity, and said membrane comprising a piece of flexible fabric woven of synthetic fiber, such as nylon.

2. The mechanism according to Claim 1 wherein the fabric is one that is woven of synthetic monofilament fiber with apertures between the strands of fiber of about one micron.

3. The mechanism according to Claim 1 or 2 wherein the synthetic fiber is a thermoplastic fiber and wherein the mechanism includes a tubular filter element of thermoplastic material, the membrane being thermoplastically sealed around its margin to one end of said tubular filter element with the membrane capable of deflection on an unsupported 0.250 inch cross-section of about 180 microns under a reduced pressure (vacuum) of about 18.0 inches of water and about 180 microns under an elevated pressure of about 9 psig.

4. The mechanism according to Claim 1 or 2 including a tubular filter element, the membrane being secured to one end of said filter element, and wherein the means providing the metering cavity comprises a hollow cylinder, and filter element being mounted in said cylinder with the membrane spaced from one end of the cylinder to provide said metering cavity, and means extending through said cylinder for supplying reduced and elevated pressure to said membrane including an attachment element in the cylinder with a quick detachable connection between the other end of said tubular filter element and said attachment element.

5. The mechanism according to Claim 4 wherein said tubular filter element and attachment element have interengageable key and keyway means, and said elements being movable out of the cylinder for disengagement and interengagement of said key and keyway means.

6. The mechanism according to Claim 5 wherein said elements have removed longitudinal sections and transverse notches forming said key and keyway means.

7. A mechanism for automatically measuring and dispensing unit quantities of dry powder constructed and adapted to operate substantially as herein described with particular reference to the embodiment illustrated in the accompanying drawing.

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1420364 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

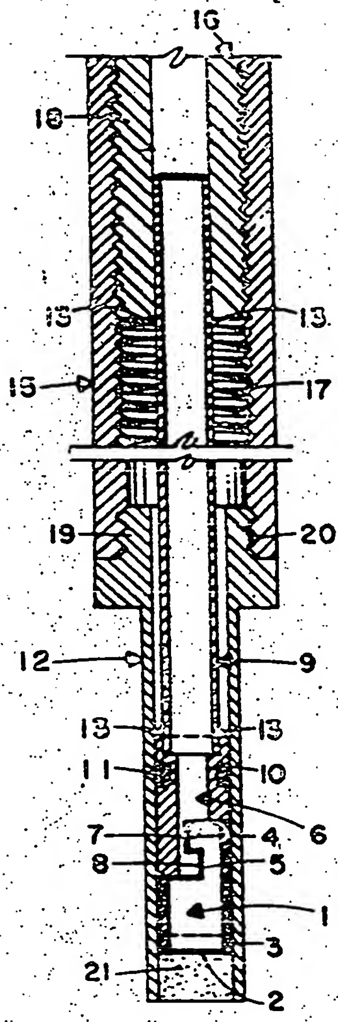

Fig. 1

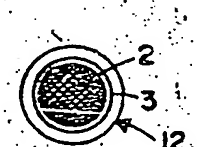

Fig. 2

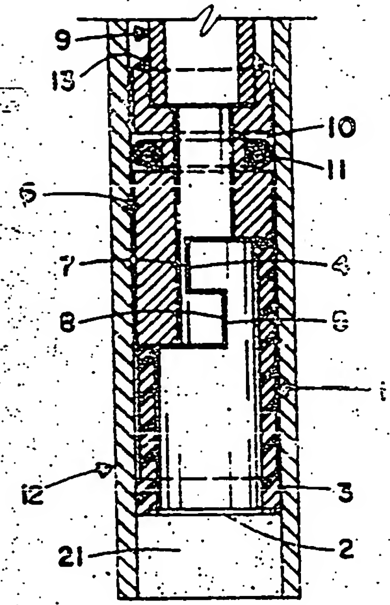

Fig. 3

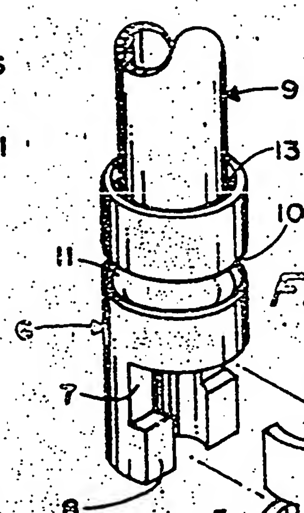

Fig. 4

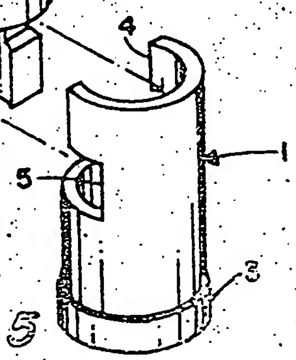

Fig. 5

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